EXCLUSIVE BUS LANE STUDY

on

INTERSTATE ROUTE 495 - NEW JERSEY ROUTE 3

from

NEW JERSEY TURNPIKE TO LINCOLN TUNNEL

REPORT ON SECOND PHASE OF FIELD TESTS IN DECEMBER 1965

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MARCH 1966

EXCLUSIVE BUS LANE STUDY

Report on Second Phase of Field Tests in December 1965

Conducted by:

NEW JERSEY STATE HIGHWAY DEPARTMENT
HUDSON COUNTY POLICE DEPARTMENT
NEW JERSEY TURNPIKE AUTHORITY
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Planning & Development Department
Central Planning Division
March 1966

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INTRODUCTION

In an attempt to maximize the utilization of the available capacity of the Interstate Route 495-New Jersey Route 3 approach through North Bergen, Union City and Weehawken, between the New Jersey Turnpike and the Lincoln Tunnel, a program is underway to determine the feasibility of establishing an exclusive bus lane on that highway. The route, locally referred to as the Union City Underpass, is a limited access freeway with three lanes in each direction. It serves a densely populated corridor as a heavily traveled journey-to-work artery.

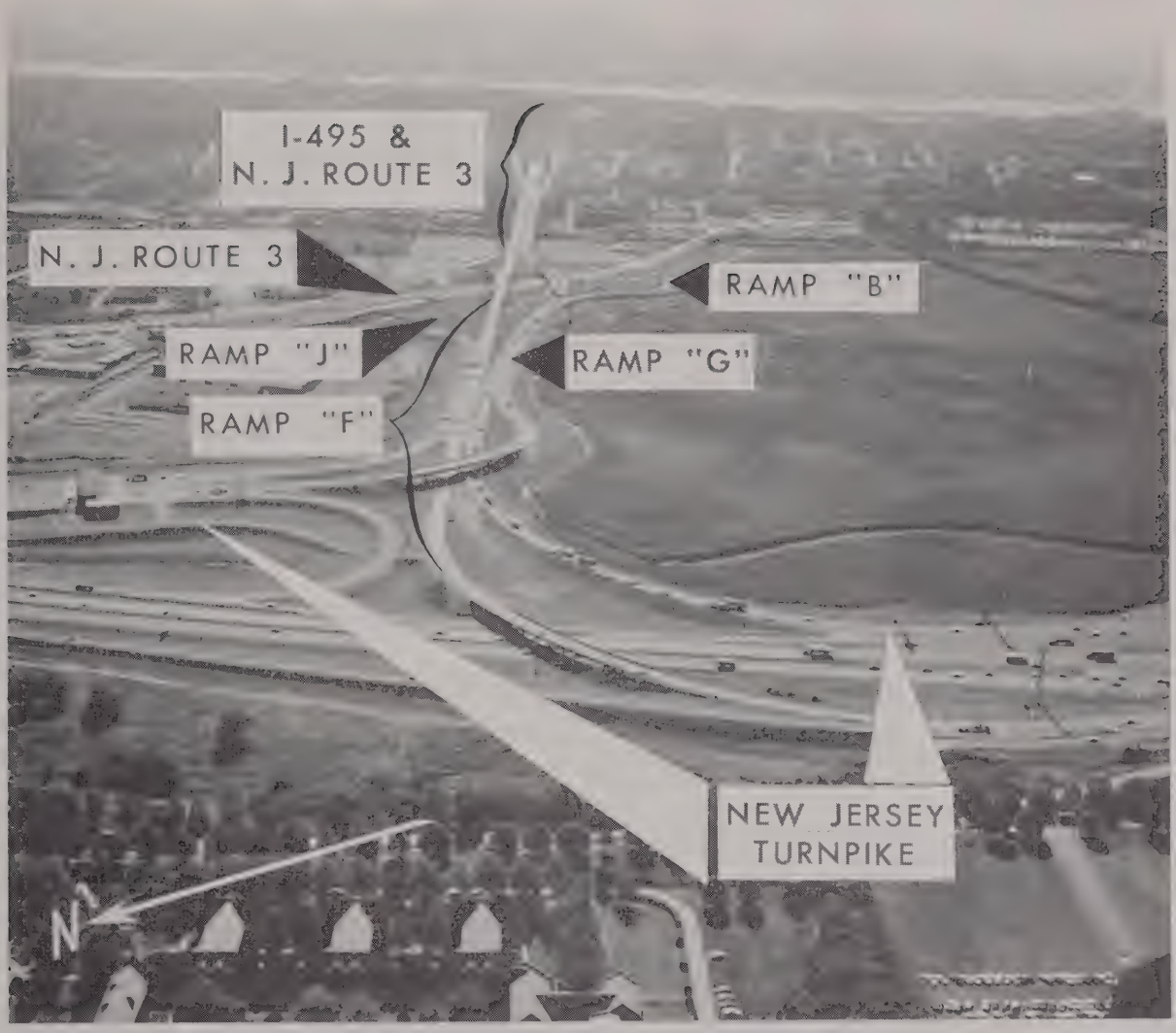
This project is a cooperative undertaking by the New Jersey State Highway Department, the Hudson County Police Department, the New Jersey Turnpike Authority and The Port of New York Authority. It has the primary objective of transporting a maximum number of people, rather than just vehicles, on this key urban freeway.

Under this concept, an exclusive bus lane on the Lincoln Tunnel approach would be utilized by Manhattan-bound or eastbound buses during morning peak periods. It should not only speed the movement of eastbound bus travelers, but also result in smoother flow for all motorists by making available additional eastbound capacity without restricting westbound flow. Thus, by utilizing operational techniques, additional peak period passenger and vehicular capacity would be provided.

Two traffic conditions exist on the freeway in question which justify a study of an exclusive bus lane. First, serious congestion is often experienced in the eastbound direction in the New Jersey Turnpike-

INTERSTATE ROUTE 495-NEW JERSEY ROUTE 3
LINCOLN TUNNEL APPROACH

LOOKING EAST AT WESTERLY END OF PROJECT



LINCOLN TUNNEL HELIX
AT EASTERLY END OF PROJECT

Route 3 interchange, and through the North Bergen Viaduct and Union City Underpass. As overall traffic increases, it is likely that even greater congestion will occur with more frequency, resulting in considerable delays to eastbound vehicles. Such future considerations as the New Jersey Turnpike widening and the possible expansion of the Port Authority Bus Terminal warrant the focusing of attention on this project at the present time.

Secondly, the flow of buses on this roadway is the heaviest in the world. The people-carrying capability of a freeway lane devoted exclusively to mass transit vehicles significantly exceeds that of the same lane employed by automobiles and buses together, or by automobiles alone. For example, eastbound private cars using the Lincoln Tunnel during average weekday morning peak periods are occupied by an average of 1.7 persons per car. Based on a possible capacity approaching 2,000 cars per hour per lane, a maximum of only 3,400 persons per hour per lane could be accommodated on the New Jersey Lincoln Tunnel approaches in passenger cars.

By comparison, over 500 eastbound buses presently traverse the Union City Underpass in the morning peak hour. With a loading factor of 50 passengers per bus, an exclusive bus lane today could accommodate some 25,000 persons per hour. Considerable reserve capacity would still be available for such a lane to handle future increased demand. Studies by the General Motors Corporation have found that an exclusive bus lane could accommodate 1,450 buses per hour at a constant speed of 33 miles per hour, and flow rates of 1,400 buses per hour at 45 miles per hour.

Thus, it appears that there is a noteworthy potential in exclusive bus lanes for improving the efficiency of urban freeways during peak journey-to-work periods. For this reason, a study of the feasibility of this concept for the Union City Underpass was initiated by the cooperating agencies.

This report analyzes the second phase of field tests in the study program, conducted on December 14, 15 and 16, 1965 (Tuesday, Wednesday and Thursday). The tests involved the operation of maintenance trucks, approximating buses in width and frontal bulk, in an easterly direction in the median lane of the westbound roadway. These experiments were designed to measure the effect of the eastbound test vehicles on normal westbound traffic and to evaluate the ability of the westbound roadway to operate smoothly with one lane out of service for westbound vehicles. The report also summarizes developments in the program to date and suggests a possible program of future steps to implement the proposed exclusive bus lane.

CONCLUSIONS AND RECOMMENDATIONS

It is concluded, based upon detailed traffic data, photographic coverage and intensive on-the-spot observation by representatives of the several participating agencies, that the second phase field tests in the exclusive bus lane feasibility program were successful. Results indicate that the test vehicles operating in the exclusive lane had no adverse effect on normal westbound traffic. In addition, since no significant congestion occurred on the westbound roadway system, the availability of reserve capacity over traffic demand was confirmed.

It is recommended that the agencies involved in the exclusive bus lane program continue their collaboration on this project. It is further recommended that their representatives meet in the near future to discuss in detail the findings in this report. In order to maintain momentum on the project, it would be appropriate at such a meeting to explore means of implementing the ultimate objectives of the program.

There is general agreement among observers of the test that the standard traffic cone would be unacceptable in dividing opposing lanes of traffic in a permanent exclusive bus lane installation. Thus, a high order of priority should be placed on a technical examination to determine more appropriate lane divider devices.

Investigation should also proceed as rapidly as practicable into a number of considerations such as: the precise location and design of the points of entry into the exclusive bus lane; traffic

control procedures and devices throughout the length of the project, including signs, signals and markings; an overall operational plan; recommendations concerning the timing and the criteria for implementing the concept on a permanent basis; operational and jurisdictional responsibility; associated costs and potential sources of funds to finance the project; and the possible need for legislative authorization.

A coordinated effort between the Hudson County Police Department, New Jersey State Highway Department, New Jersey Turnpike Authority, and The Port of New York Authority would be the most effective means of developing a workable exclusive bus lane on a permanent basis. Each of these agencies has had extensive experience in several of the elements of the program, and all have operating responsibilities in connection with it. In addition, liaison should be maintained with appropriate Federal officials throughout the development of the project. Continuation of the close working relationships which the staffs of the cooperating organizations have maintained in the past should lead to early progress toward ultimate implementation of the exclusive bus lane concept.

BACKGROUND OF FEASIBILITY STUDY

Preliminary Study

In December 1963, a report was prepared by the Port Development Department (now the Planning and Development Department) of the Port Authority entitled "Preliminary Study of a Possible Exclusive Bus Lane for the Lincoln Tunnel Approaches." This document presented an analysis of the physical and functional feasibility of the exclusive bus lane. It was prepared in anticipation of possible problems in maintaining high levels of journey-to-work bus service following the reconstruction of the New Jersey Turnpike/Secaucus Interchange/New Jersey Route 3 complex.

Three basic plans were considered and each analyzed in accordance with numerous criteria. The operational scheme finally selected for further testing was the reversal of the westbound lane next to the median divider, converting it to an eastbound lane during morning peak periods for the exclusive use of Manhattan-bound buses. Such a reversal would be compatible with a four-lane eastbound and two-lane westbound operation in the Lincoln Tunnel.

During afternoon peak hours, the New Jersey highway routes leading westbound from the Union City Underpass were considered to possess adequate capacity to absorb the foreseeable future traffic from the Underpass. Thus, it did not appear necessary to establish an exclusive westbound bus lane on the Helix or in the Union City Underpass during the afternoon. This expectation has been confirmed by present traffic conditions which are relatively free-flowing in these peak hours.

The concept of the exclusive bus lane and a proposal for a series of field tests was presented to key representatives of the New Jersey State Highway Department. Reaction to the project was favorable and the Highway Department agreed to a joint program with the Port Authority in carrying out the tests. Thus, in September 1964, the New Jersey State Highway Department and the Port Authority collaborated on the initial field tests described below.

First Phase of Field Tests

The initial tests were designed to evaluate the ability of the two remaining westbound lanes to carry the anticipated morning peak period flow. The most critical area to be examined was that portion of the Union City Underpass between Pleasant Avenue and Kennedy Boulevard (please refer to location map following page 9), primarily because of the relatively heavy volumes on the Pleasant Avenue entrance ramp.

These experiments were conducted for four days in September 1964 - Tuesday, September 1st; Wednesday, September 2nd; Thursday, September 3rd; and Monday, September 14th. During the test, the "exclusive lane" was coned-off with rubber traffic cones, thereby isolating it from use by westbound vehicles, although no vehicles were actually operated in the lane. On the Helix, the two westbound lanes adjacent to the median were coned-off, leaving two lanes available for westbound flow in this section. From the top of the Helix to Bergenline Avenue, a three-lane section, only the single median lane was coned-off, again leaving two lanes for westbound flow. Bergenline Avenue is about one-quarter of a mile to the west of the Pleasant Avenue on-ramp, far enough

for the effects of restricting westbound flow in that section to two lanes to be adequately measured by this procedure.

Traffic counts were made at seven points throughout the test section and aerial photographs were taken from a Port Authority helicopter. In addition, observers from the New Jersey State Highway Department and the Port Authority were present throughout the tests.

It was concluded both from the photos and the personal observation that no significant congestion occurred in the test section during the experiment. Traffic volumes indicated that sufficient reserve capacity existed to enable the westbound roadway to be operated into the foreseeable future with only two lanes during the morning peak period.

As a result of these conclusions, the cooperating agencies formulated plans for a subsequent phase of the test program involving the passage of vehicles in the exclusive lane. An analysis of the second phase tests is presented in the following chapter.

ANALYSIS OF SECOND PHASE OF FIELD TESTS

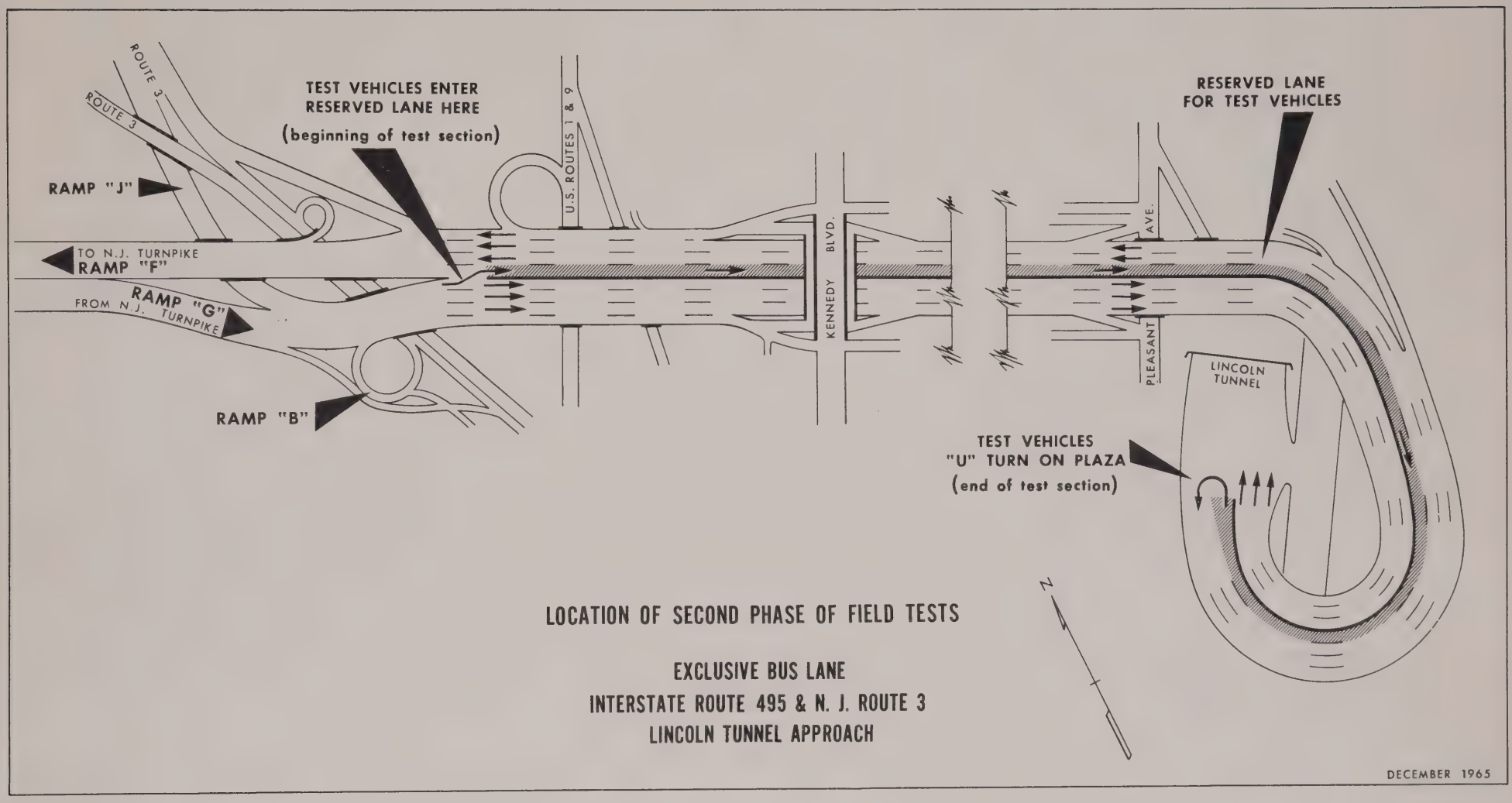
Test Objectives

Evaluation of the effect which the test vehicles, moving eastbound in a normally westbound lane, produced on traffic proceeding westerly in the remaining lanes was the primary objective of the second phase of field tests. Maintenance vehicles, approximating the dimensions of buses, were used to simulate buses for this phase of the study.

A further purpose was a confirmation of the conclusion, reached in the September 1964 tests, that the critical section of the Union City Underpass and the Helix can function smoothly with one of its normal westbound lanes closed during morning peak periods. The second test series expanded this phase of the investigation through the entire length of the Underpass and the North Bergen Viaduct and onto the westbound ramp leading to the New Jersey Turnpike.

Test Procedure

As a result of excellent cooperation among the staffs of the Hudson County Police Department, New Jersey State Highway Department, New Jersey Turnpike Authority and The Port of New York Authority, all phases of the field tests were performed in accordance with procedures developed at a joint meeting of the above agencies early in December 1965. Originally scheduled for three consecutive days, beginning Monday, December 13, 1965, the tests were delayed one day by inclement weather and were conducted instead on Tuesday, Wednesday and Thursday, December 14, 15 and 16, 1965.



LOCATION OF SECOND PHASE OF FIELD TESTS

EXCLUSIVE BUS LANE
INTERSTATE ROUTE 495 & N. J. ROUTE 3
LINCOLN TUNNEL APPROACH

DECEMBER 1965

Involved in the field tests were approximately two miles of roadway, depicted in the photographs following page 1, extending from the Lincoln Tunnel toll plaza, up the Helix, through the Union City Underpass and North Bergen Viaduct, and onto a portion of westbound Ramp "F" leading to the New Jersey Turnpike. Two lanes of the Helix and one lane of the balance of the test section were closed to westbound traffic, by means of placing standard rubber cones and appropriate temporary signs. New Jersey State Highway Department and Port Authority forces shared the responsibility of coning and signing the test section.

Preparation for the tests began on each of the three days at 6:30 A.M. when New Jersey State Highway Department and Port Authority trucks departed from the Lincoln Tunnel Administration Building. To isolate the exclusive lane, the Port Authority crew placed cones from the toll plaza up the Helix as far as Pleasant Avenue, which is the limit of Port Authority jurisdiction on the Lincoln Tunnel approach. At that point, the Highway Department continued the coning until the end of the test section.

Prior to the coning operation, signs informing westbound motorists that the left lane was closed to them because of opposing traffic had been placed at several locations on lampposts along the median divider of the Helix by Port Authority forces, but covered to prevent any distraction to westbound motorists prior to the actual test. As the cone trucks passed each sign, its cover was removed.

In the Union City Underpass, larger signs reading "Lane Closed" were placed on the bridges over the highway. New Jersey State Highway

Department men lowered these signs, which were supported by chains from the bridge railings, as the cone truck was placing cones on the roadway beneath the bridge.

While the signing and coning operations were proceeding, twenty-one maintenance trucks, contributed in equal numbers by the New Jersey State Highway Department, the New Jersey Turnpike Authority and the Port Authority were assembling along a shoulder of eastbound New Jersey Route 3 just west of the beginning of the test section. Considerable rainfall during the weekend preceding the test made it necessary to change to this location from an assembly area which would have enabled the test vehicles to enter Ramp "J" on the left side, and thus produce minor interruption with the other traffic flow into the interchange. The new assembly area made it necessary for traffic to be halted for a brief period to enable each group of test vehicles to traverse Ramp "B" from eastbound Route 3, weave across both eastbound Ramp "G" from the New Jersey Turnpike and Ramp "J," and enter the exclusive lane. Efficient traffic control operations by the Hudson County Policy Department made it possible for this critical portion of the test to be handled smoothly.

The twenty-one test vehicles were divided into three groups. This allowed for five passes through the exclusive lane at fifteen-minute intervals, beginning at 7:45 A.M. and ending at 8:45 A.M. Because of the short length of the section, it was possible to use the first two groups of vehicles for two runs each and the third group for one run.

At 7:45 A.M., the first group of vehicles left the assembly area and proceeded, with headlights and flashers on, into the exclusive

lane with Hudson County Police assistance. They traveled at approximately twenty-five miles per hour through the lane to the Lincoln Tunnel Plaza, made a U-turn and returned to the starting point through normal westbound traffic.

To accomplish the objective of determining the effect of the operation on westbound traffic, photographic coverage of the tests was performed by the "Sky Count" method. This technique involved the flying of a Port Authority helicopter at an altitude of 1,200 feet directly over the second test vehicle in each of eight test vehicle groups during the first two days of the test. A reconnaisance camera equipped with a wide-angle lens took a vertical photograph every six seconds throughout the time the vehicle was in the exclusive lane. This combination of altitude and camera lens produced coverage of an area large enough to observe the movement of all the test vehicles and the westbound traffic approaching the platoon of maintenance trucks. In addition, a series of westbound ground vehicular traffic counts were taken by Port Authority personnel.

At the conclusion of each morning's test, the cones and the signs lowered from bridge railings were removed. Signs on the median divider of the Helix were covered after the first two tests and removed following the final test.

Second Phase Test Results

Effect on Westbound Traffic

Study of the aerial photographs indicated that a meaningful measurement of the degree to which the eastbound test vehicles affected opposing traffic could be derived by observing the lateral placement of

View to the West at Kennedy Boulevard Entrance Ramp
Showing Eastbound Trucks in Westbound Median Lane

View to the East at Pleasant Avenue Entrance Ramp
Showing Eastbound Truck Platoon in Distance, Left of Median Divider

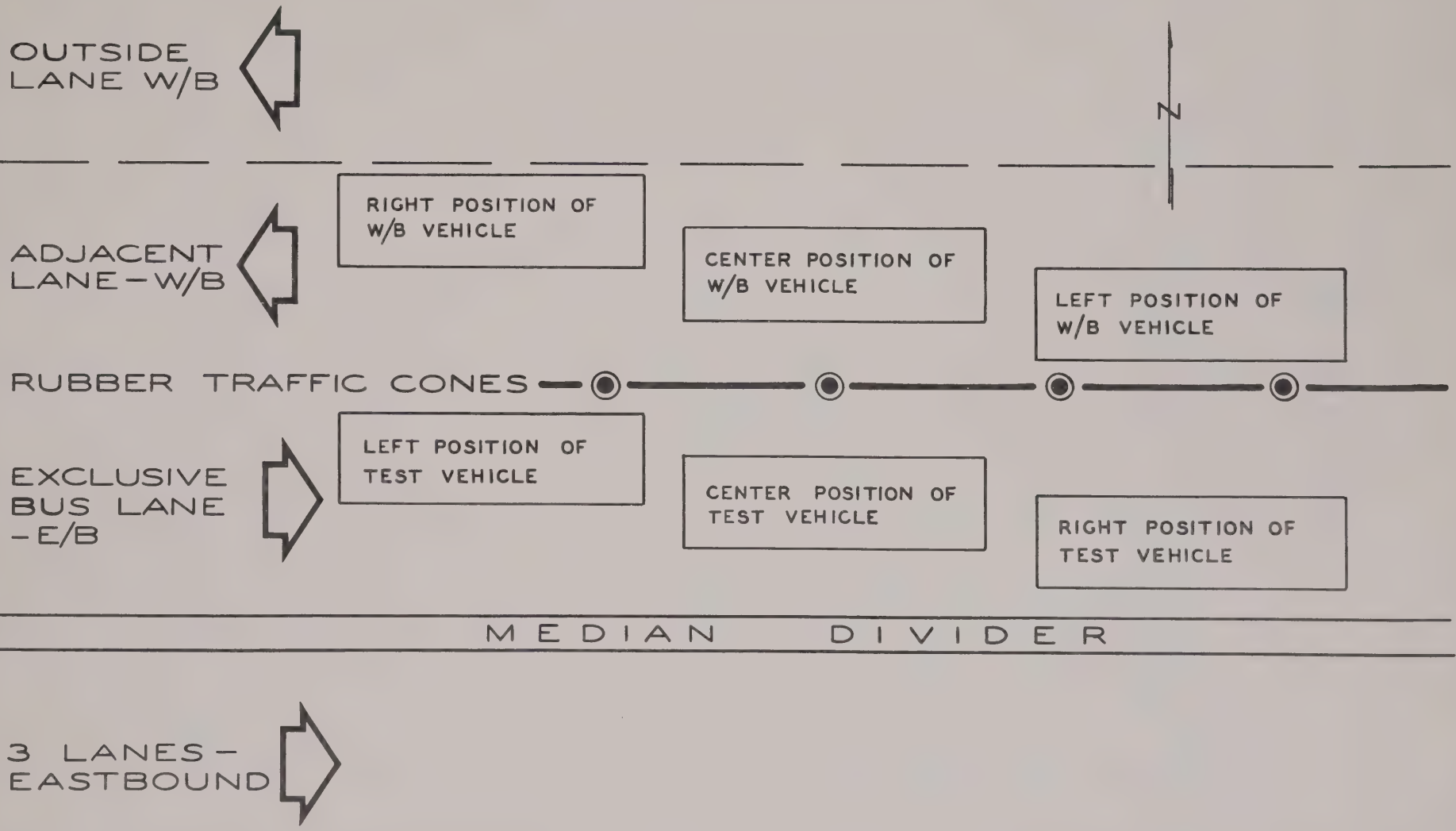
westbound vehicles in the lane adjacent to the exclusive lane. As a westbound vehicle and the leading eastbound test truck approached each other, or "interacted," they each became laterally placed in their respective lanes in positions categorized as "right," "center" or "left" for the purpose of this study. This criteria is depicted in the schematic diagram on the following page.

In conjunction with the above criteria, it was assumed that if a westbound vehicle was positioned in the left or center portions of the lane adjacent to the exclusive lane, it could be classified as unaffected by the test trucks. Westbound vehicles moving to the right position were considered to be affected to some degree, while those vehicles which changed lanes to the right were deemed adversely affected.

Quantitative results of this analysis are presented on the following page. A most significant conclusion is that a negligible number of westbound vehicles changed lanes - only four of a total of 682 interactions measured on two test days. This appears to be strong evidence that there was practically no adverse effect on westbound motorists.

Analysis of the photographs and field observations revealed that approximately half of the westbound vehicles were somewhat affected, as evidenced by movement to the right position. It is possible that the relatively large width of the rubber traffic cones, in conjunction with the presence of the test vehicles, played a role in this lateral movement, especially since the figures indicate that virtually all of the maintenance trucks remained in the center of the exclusive lane. Some

SCHEMATIC DIAGRAM OF EXCLUSIVE BUS LANE AND ADJACENT WESTBOUND LANE SHOWING CRITERIA USED IN DETERMINING LATERAL POSITIONS OF VEHICLES IN EACH LANE


OUTSIDE LANE W/B
N
ADJACENT LANE – W/B
RIGHT POSITION OF W/B VEHICLE
CENTER POSITION OF W/B VEHICLE
LEFT POSITION OF W/B VEHICLE
RUBBER TRAFFIC CONES
EXCLUSIVE BUS LANE – E/B
LEFT POSITION OF TEST VEHICLE
CENTER POSITION OF TEST VEHICLE
RIGHT POSITION OF TEST VEHICLE
MEDIAN DIVIDER
3 LANES – EASTBOUND

LATERAL DISPLACEMENT DATA
FOR OPPOSING VEHICLES

	Westbound Vehicle				Number of Interactions	Eastbound Test Vehicle		
	Left	Center	Right	Lane Change		Left	Center	Right
	(in % occurrences)					(in % occurrences)		
8:00 A.M.-9:00 A.M., Tuesday, December 14, 1965								
8:00-8:15	1.0	45.0	54.0	0	88	1.0	99.0	0
8:15-8:30	0	50.0	50.0	0	28	0	100.0	0
8:30-8:45	0	43.0	57.0	0	92	3.0	97.0	0
8:45-9:00	0	46.0	54.0	0	100	0	99.0	1.0
8:00-9:00 weighted	0.3	45.5	54.2	0	308	1.3	98.4	0.3
8:00 A.M.-9:00 A.M., Wednesday, December 15, 1965								
8:00-8:15	0	46.0	53.0	1.0	76	0	100.0	0
8:15-8:30	0	39.0	61.0	0	80	4.0	96.0	0
8:30-8:45	0	30.1	67.0	2.9	103	0	100.0	0
8:45-9:00	1.0	51.0	48.0	0	115	1.0	97.0	2.0
8:00-9:00 weighted	0.3	41.7	56.9	1.1	374	1.1.	98.4	0.5
Two day weighted averages	0.3%	43.4%	55.7%	0.6%	682	1.2%	98.4%	0.4%

cones were knocked down by passing vehicles, perhaps causing some of the shifting to the right position in the lane.

Since it appears that the standard rubber traffic cone is generally unacceptable in dividing opposing lanes of traffic on a permanent basis, a technical examination of more appropriate lane dividers has been recommended. Research efforts in recent years have produced a variety of feasible devices which can effectively separate opposing traffic when required to do so, but retract when not in use to provide maximum utilization of the roadway. A thorough, joint investigation by the cooperating agencies could result in the development of a practical substitute for the traffic cone.

Measurement of Westbound Capacity

The second phase of tests confirmed and reinforced the findings of the initial field tests held in September 1964, and expanded the evaluation of westbound roadway capacity beyond the point where those tests ended. In the December 1965 tests, the cone line was extended through the entire length of the Union City Underpass and the North Bergen Viaduct and onto a portion of westbound Ramp "F" leading to the New Jersey Turnpike. Test vehicles did not operate on the ramp. This enabled observers to evaluate traffic flow at the on-ramp from Kennedy Boulevard and also to determine the ability of Ramp "F," which is two lanes wide where the cones were placed, to function with only one lane available for westbound vehicles. This New Jersey Turnpike ramp analysis is important because of the possibility that, under a permanent operating plan, it would be utilized as a two-way roadway during periods of exclusive bus lane operation.

No congestion existed at any time in the westbound direction on the approximately two-mile portion of the roadway with the exception of some minor delays during the first fifteen-minute period on the first morning. This occurred at the easterly end of the North Bergen Viaduct where the westbound roadway widens to four lanes at the entrance ramp from Kennedy Boulevard. Throughout the four lane section rubber cones had been mistakenly placed as an extension of the cone line through the Union City Underpass, thus isolating two lanes of the four for the exclusive bus lane and leaving only two lanes for the substantial weaving maneuvers which take place in that section. This produced some momentary stoppages, the effects of which extended partially through the Union City Underpass. Immediate police response to the situation involved realignment of the cones to provide three lanes of the four for westbound traffic. This prompt action quickly restored free flow conditions. Other than this temporary problem, there was no visible effect on the westbound traffic stream.

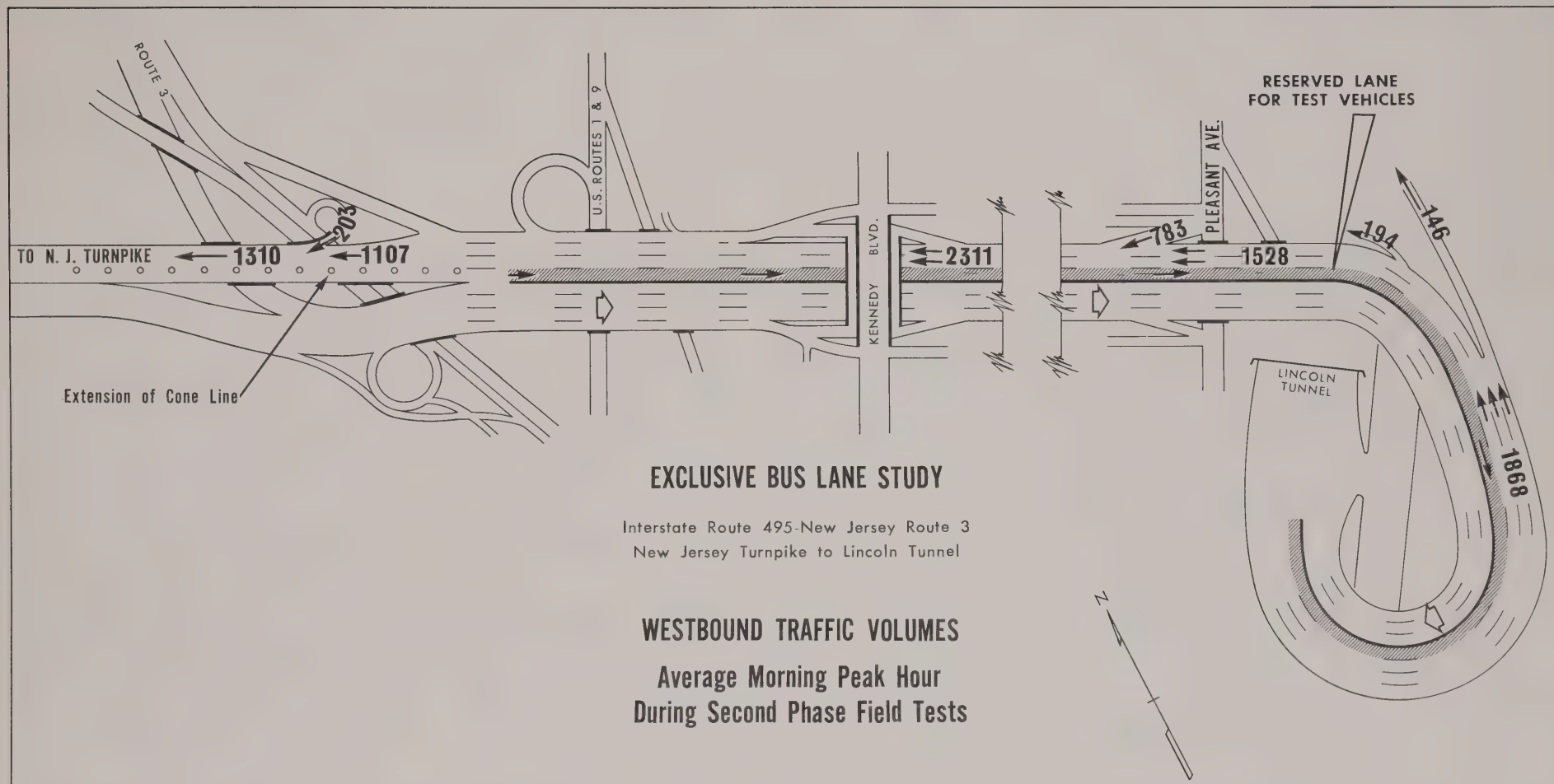
Peak hour westbound traffic volumes throughout the test section during the three-day period are presented in the table below and on the map following this chapter. Eastbound volumes were not recorded during the tests.

The westbound volumes were observed during free flow conditions in all sections of the test area, indicating that the westbound roadway system can operate smoothly with one lane removed. Conversion of the observed volumes to an equivalent passenger car basis, and comparison

of the converted volume to the computed possible capacity of the route, reveals that free flow conditions should prevail under anticipated traffic volumes into the foreseeable future.

PEAK HOUR WESTBOUND VEHICLES

Location	Tues. Dec. 14 7:40-8:40 AM	Wed. Dec. 15 7:30-8:30 AM	Thurs. Dec. 16 8:00-9:00 AM	Average
Helix	1849	1912	1844	1868
Off-Ramp to Kennedy Blvd. East	144	157	137	146
Off-Ramp to Pleasant Avenue	205	183	194	194
To Union City Underpass from Helix	1595	1612	1448	1552
To Union City Underpass from Pleasant Avenue	805	837	707	783
Entering Union City Underpass	2400	2449	2155	2335
From North Bergen Viaduct to New Jersey Turnpike	1108	1125	1087	1107
From N. J. Route 3 to New Jersey Turnpike	207	240	163	203



EXCLUSIVE BUS LANE STUDY

Interstate Route 495-New Jersey Route 3
New Jersey Turnpike to Lincoln Tunnel

WESTBOUND TRAFFIC VOLUMES

Average Morning Peak Hour
During Second Phase Field Tests

INTEREST OF THE FEDERAL GOVERNMENT IN EXCLUSIVE BUS LANES

In its role of administering the federal highway program, the Bureau of Public Roads has expressed considerable interest in exclusive bus lanes. Mr. E. H. Holmes, Director of Planning for the Bureau, stated in an April 1964 address: "The Bureau of Public Roads takes the position that such reservation is reasonable if the usage by bus passengers exceeds the number of persons that would normally be moved in the same period in passenger cars - say 3000 per hour."

Utilization of the reserved lane under this plan for the approach to the Lincoln Tunnel would, on the basis of the volume of buses currently using the roadway section, be far in excess of 3000 persons per hour. Any increase in bus operations in the future would, of course, involve even greater use of the exclusive lane.

Representatives of the Bureau of Public Roads were present on the first day of the second phase field tests in December 1965, and expressed enthusiasm concerning the project. The staffs of all of the agencies involved in the program are optimistic of the potential role of exclusive bus lanes in improving the efficiency of urban freeways during peak journey-to-work periods.

Because of governmental enthusiasm for the type of undertaking involved in this project, and because of the far-reaching consequences the program could have on the transportation planning for all urban areas, it is suggested that the agencies involved in the exclusive bus lane study maintain close contact with the Bureau of Public Roads throughout the development phases of the study.

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